

IMS Workshop on PDEs

January 25-26, 2019 (Friday & Saturday)

TITLE & ABSTRACT

Estimates of Eigenvalues for Subelliptic Operators on Compact Manifolds

Professor Hua CHEN

Wuhan University

Let $X = (X_1, X_2, \dots, X_m)$ be a system of real smooth vector fields defined on a smooth compact manifold M which is endowed with a smooth positive measure μ . Assume X satisfies the Hormander's condition, then the formally self-adjoint operator $\Delta_X = -\sum_{i=1}^m X_i^* X_i$ is a sub-elliptic operator. Denote λ_k to be the k -th eigenvalue for the sub-elliptic operator Δ_X on M . We shall give a lower bound of λ_k and also establish an explicit asymptotic formula of λ_k under a certain condition. Actually, this condition is necessary for such asymptotic result to be hold. Thus it can be obviously deduced that our lower bound estimate for λ_k is optimal in the sense of the order of k .

Some results on compressible non-Newtonian fluids

Professor Zhenhua GUO

Northwest University

In this talk, I will survey some recent results on global well-posedness and large time behaviors of the solution of the compressible non-Newtonian fluids. This is a joint-work with Li Fang, Jinjing Li, et al.

Global smooth solution to nonlinear wave equations with non-compact data

Dr. Fei HOU

Nanjing Normal University

In this talk, we first review previous works on null condition and weak null condition of nonlinear wave equations. Then I will show the global existence of small smooth solutions to two dimensional nonlinear wave equations with non-compact Cauchy data. A type of weighted $L^\infty - L^\infty$ estimates is applied to get better time decay of the derivatives which are tangent to the outgoing light cone. This is a jointwork with Prof. Huicheng Yin.

The dilute gas flow in a finite channel

Dr. Shuangqian LIU
Jinan University & CUHK

The motion of the particles in the dilute gas can be described by the Landau equation or the non-cutoff Boltzmann equation. It is known that it is quite hard to construct the global well-posedness in Sobolev space for the initial boundary value problems of the kinetic equations in general bounded domains due to the formation of singularity of solutions. In this talk, firstly, we will discuss how to establish the global existence in some sharp regularity space for both the Landau equation and the non-cutoff Boltzmann equation with either the inflow boundary condition or the specular reflection boundary condition in a finite channel, secondly, we will show the solutions tend to the equilibrium around a global Maxwellian with the time sub-exponential decay rates, thirdly, we will present the regularity of the initial data or boundary data can be propagated from the boundary into the interior of the channel along the tangential direction. This is partly joint work with R. Duan, S. Sakamoto and R. Strain.

Traveling Waves and Global Stability to Time-Delayed Reaction-Diffusion Equations with Degenerate Diffusion

Professor Ming MEI
Champlain College St.-Lambert and McGill University

In this talk, I will present our current research results on traveling waves for time-delayed reaction-diffusion equations with degeneracy. Different from the existing studies where there exists a minimum wave speed for the traveling waves in the case of mono-stable type equations like Fisher-KPP, we recognize that, for the local reaction-diffusion equations with degenerate diffusion and time-delay, there is no traveling wave with minimum speed, namely, the waves exist only for all speed $c > 0$, but not for $c < 0$ nor $c = 0$. The global stability in L^1 -weighted space is also proved. This talk is based on our two recent papers joint with Rui Huang, Chunhua Ji, Jingxue Yin published in J. Nonlinear Sci. (2018), and joint with Tianyuan Xu, Shanming Ji and Jingxue Yin in J. Diff. Eqn. (2018).

Free boundary problems of degenerate potential equations and sonic jet flows from convergent nozzles

Professor Chunpeng WANG
Jilin University & CUHK

This talk concerns the compressible sonic jet flows from two-dimensional convergent nozzles with straight solid walls, which are governed by free boundary problems for a degenerate elliptic equation. The sonic jet problems are formulated and solved. Furthermore, the properties of the flows are shown.

Global Solution of the Stokes Approximation Equations in Three-Dimensions

Professor Weike WANG
Shanghai Jiao Tong University

In this talk, we will prove the global existence of classical solution to Cauchy problem for the Stokes approximation equations in 3D by using the Green’s function method and part positive method.

Kinetics models of chemotaxis with temporal sensing mechanism: the parabolic limit and its dynamics

Professor Zhi-An WANG
Hong Kong Polytechnic University

It is well-known that the Keller-Segel type chemotaxis system can be derived as the parabolic limit of the kinetic model describing the velocity-jump process. When the tumbling kernel depends on the temporal gradient of chemical concentration, the rigorous parabolic limit of the kinetic model has not been completely understood. In this talk, we shall report a result for such scenario where the tumbling kernel depending on temporal gradient of chemical concentration is a decreasing smoothed stiff signal response function. We show that parabolic limit of the kinetic model with such tumbling kernel will result in a flux-limited chemotaxis system, which has some distinct features than the classical Keller-Segel model. This is a joint work with B. Perthame and N. Vauchelet.

Subsonic and transonic shock flows in three dimensional bounded nozzles

Professor Shangkun WENG
Wuhan University

In this paper, I first present the structural stability result of the spherical symmetric transonic shock solutions under the axisymmetric perturbation of the nozzle wall and also the supersonic incoming flow including the swirl component. Secondly, I will discuss a deformation-curl decomposition for the three dimensional steady Euler system. The new issue in this decomposition is that we can construct a smooth subsonic flows with same regularity for the pressure and the velocity. This talk is based on collaborations with Prof. Chunjing Xie and Prof. Zhouping Xin.

Structural stability of Poiseuille flows in nozzles

Professor Chunjing XIE
Shanghai Jiao Tong University

In this talk, we will investigate the local stability of Poiseuille flows for axially symmetric Navier-Stokes equations with swirls. The key ingredient for the analysis is the study for the associated linearized problem for Navier-Stokes equations.

Magnetic effects on stability of boundary layer

Professor Feng XIE
Shanghai Jiao Tong University

In this talk I will discuss the effects of magnetic field on the stability of boundary layer, which include the local well-posedness theory, validity of boundary layer expansion, long-time existence of solutions etc. By comparing with the classical boundary layer theory for pure hydrodynamics, it shows that some suitable magnetic fields have the stabilizing effects on the boundary layer for both local-in-time and long time cases. This talk is based on joint works with Chengjie Liu and Tong Yang.

Exterior Problem of the Linear Vlasov-Poisson-Boltzmann System

Professor Tong YANG
City University of Hong Kong

We will present in this talk a linear theory on a flow under the effect of self-induced electric field past an obstacle governed by the Vlasov-Poisson-Boltzmann equation. The bulk velocity at infinity acts like a driving force on the flow so that some non-trivial stationary solution profile exists. Similar to Ukai-Asano's work on the exterior problem for the Boltzmann equation, the spectrum of the linear operator is used through an approach in the spirit of the limiting absorption in scattering theory. However, to take care of the electric potential that satisfies the coupled Poisson equation, a new decomposition of the solution operator is needed to show the compactness. This is a joint work with Hongjie Dong and Mingying Zhong.

On the weak shocks and strong shocks for the supersonic flow past sharp bodies

Professor Huicheng YIN

Nanjing University

It is described in Courant-Friedrichs' book "Supersonic flow and shock waves" (see Pages 313-314, Page 414): When an incoming supersonic flow from minus infinity hits a cone or wedge, if the angle of the cone or wedge is less than a critical value, then there will appear an attached weak shock (supersonic shock) or strong shock (transonic shock). A Longstanding natural conjecture is: It has frequently been stated that the weak shock is stable and the strong shock is unstable, therefore, only the weak one could occur. However, a convincing proof of this instability has never been given. In this talk, from the mathematical point of view, we will systematically discuss the global well-posedness/ill-posedness problems of the related weak shocks/strong shocks.

The Vlasov-Poisson-Landau system near a local Maxwellian

Professor Hongjun YU

South China Normal University

In this talk, we discuss about the stability the Vlasov-Poisson-Landau system with the physical Coulomb potential near a local Maxwellian. The macroscopic components of this local Maxwellian are the approximate rarefaction wave of the one dimensional Euler equations.